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THE COMPARISON OF COMPOSITION, PHYSICO-CHEMICAL PROPERTIES OF COW AND CAPRINE MILK

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ABSTRACT

India's livestock sector is one of the largest in the world. India's milk production is estimated to have 176.35 million tonnes (provisional) during in 2017-18. The goat is one of the main contributor of dairy and it produces about more than 2 per cent of the world's total annual milk supply. India has witnessed an increasing trend of goat milk production with a growth rate of 3.82 percent during 2015 – 16.

The composition of goat milk differ slightly to cow milk with fat, protein, lactose and mineral content but their physico-chemical properties are various. The caprine milk has lesser ($p>0.05$) specific gravity, viscosity, freezing point & pH but higher ($p<0.05$) surface tension, refractive index, electrical conductivity & acidity which was found to be statistically insignificant compared to cow milk. The certain processing parameters of caprine milk of HCT and RCT were statistically lower ($p> 0.05$) compared to cow milk.

Goat milk is highly nutritious, health benefits and widely consumed in many parts of the world. Therefore, awareness about the advantage of consumption of goat milk should be popularized in India so that production and utilization of goat milk could be enhanced.

***KEYWORDS*: Composition, Physico-Chemical Properties, HCT & RCT, Caprine & Cow Milk**

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Original Article

INTRODUCTION

India's livestock sector is one of the largest in the world, having with a holding of 11.60 percent of the world's livestock population, which consists of buffaloes (57.83%), cattle (30.39 %), and goats (17.93 %). Growth in the livestock sector has consistently exceeded that of the crop sector (as per 19th Livestock census, 2012) [5]. The total demand for the animal products in the developing countries is expected to be more than double by 2030 [8]. The goat which was also known as "poor man's cow" in India and "wet nurse of infant" in the United

Kingdom was the first animal to be domesticated.

India's milk production is estimated to have increased by 6.6 percent to 176.35 million tonnes (provisional) during in 2017-18 and 165.4 million tonnes in 2016-17. The per capita consumption has risen to 355 grams per day in 2016- 17. Out of these, the growth rate of cow milk 10.87 percent, Buffalo milk 2.34 per cent and Goat Milk 3.82 percent is significantly contributing to the Indian economy [18, 19]. Goat numbers were increased in the world with Asia to keep constantly the first place, having a contribution about 59.40 per cent. Among the Asian Countries, South Asian countries, including India, Bangladesh and Pakistan are the major producers of goat milk, whereas in Europe, the most developed dairy goat industry is present in France, Greece, Spain and Italy [13]. There are twenty well defined breeds of goats in India, although 70 percent population is non-descript and meat type. Some of the breeds such as Jamunapuri, Barbari, Beetal, Surti, Jakrana produce a fairly good amount of milk.

Caprine milk differs from cow milk in composition with respect to fat, protein, lactose, mineral and vitamin profile. It contains higher protein and ash, but lower lactose content than human milk. Caprine milk exhibit great deal of variation in the mineral composition and as well as vitamin profile. The mineral contents of caprine milk have high potassium, magnesium, chlorides and less sodium and sulphur contents than cow milk and it supplies an adequate amount of vitamin-A and niacin, excesses of thiamine, riboflavin and pantothenate. Caprine milk's fat has smaller fat globules, it is easier to digest than cow milk. Further, the exact composition varies according to many factors like breeds, individual animal, lactation, health condition, environmental condition etc. [20].

The caprine milk is different from cow and human milk in composition, nutritional and therapeutic attributes. The compositional difference is the variety of physicochemical characteristics of cow and caprine milk is an essential for successful development of dairy goat farming, improvement in processing technology as well as for marketing of goat milk products. Therefore, awareness about the advantage of consumption of goat milk should be popularized so that production and utilization of goat milk could be enhanced [17, 20].

Caprine milk has a comparatively less amount of total solids 12.9±1.01 percent, followed by cow milk 13.5 ± 1.22 percent. The total solids in the Exotic Caprine breeds like Saanen, Camosciata, Ionica, Garganica, Maltese which has 12.02, 11.95, 12.65, 13.8 and 13.85 per cent total solids content in their milks which includes fat and non-fat materials [6].

The physico - chemical properties of caprine milk have the highest acidity, viscosity, electrical conductivity, and surface tension. The goat milk has the lowest specific gravity, proteolytic activity, freezing point, lipase activity, RCT and HCT compared to cow milk. Goat milk has the highest refractive index compared to cow milk, whereas lowest refractive index compared to cow milk. After 14 h when goat milk was observed, it was found that milk became thicker, but the curd formed was having very weak consistency [11].

The acidity of caprine milk is expressed as the percentage of lactic acid. The values of acidity of milk samples collected from the cow and caprine milk were in the range of 0.14-0.16 per cent and 0.14 - 0.18 per cent, Lactic Acid (LA). The higher level of acidity is mainly contributed to the presence of higher amounts of caseins, lactates, phosphates and citrates [14].

The pH value obtained for cow milk was 6.59-6.67 and 6.48-6.64 in goat milk. When measuring the goat breeds milk. The pH measured between the two breeds Saanene of South Africa and Chamoisée breeds of Greece throughout the lactation period found the variations between 6.5 and 6.8. Fresh milk acts as a complex buffer because of ionizable groups

of proteins, phosphates, citrates and a number of minor constituents. Bacterial action introduces lactate and other organic anions as an additional buffer [10].

The technological processing parameters which includes heat coagulation time (time required to coagulate upon heating), and Rennet Coagulation Time (RCT) (time required to coagulate the milk by enzyme) are very useful during processing of milk and preparation of milk products which are beneficial to standardise the procedure for production of goat milk products. Goat milk has shorter RCT, less resistance to heat treatment, weaker curd and low cheese yields which explain the significant differences from cow and other milk in digestion by infants and age olds which are traditionally have been explained the "natural homogenized" goat milk fat [4, 9].

MATERIALS AND METHODS

Milk Samples

The indigenous and exotic caprine breed milk samples were collected from Sinchana goat and sheep farm, Marenahalli village (Bengalru Rural Dist) and Yashodhavana Goat Farm (Mysuru) and cow milk samples were collected from Dairy Farm, Hebbal, KVAFSU Bengaluru.

Chemicals

The chemicals used for milk composition analysis and various properties were of analytical grade.

The Compositional analysis of cow and goat milk of Fat, Protein, Lactose, Total ash and Total solids content were analysed as per [2]. Physico-chemical properties of caprine milk samples were used for analysing properties such as specific gravity (lactometer), viscosity (Oswald viscometer), surface tension (Stalagmometer), Freezing Point, Refractive Index, Electrical conductivity were analysed by ultra-milk analyser, pH (pH meter) and acidity (Titration) as described in [2]

The caprine milk samples were also analysed for The HCT of milk samples and estimated by the subjective method adopted by [3] at 140□ and RCT of milk samples were estimated by the subjective method of [7] at 30□, which are essential parameters for the processing of milk and milk products.

STATISTICAL ANALYSIS

Experimental data obtained in the study was analyzed by Randomized column block design as per the method described by [15] to test for 'F' values to know the statistical significance. Critical Difference (CD) value was calculated to determine whether the treatment means were similar or not. The analysis was done using the SPSS software package and MS Excel 2007.

RESULTS

Gross Composition of Caprine and Cow Milk

The average gross compositions of caprine and cow milk are presented in the Table 1 and Figure 1. The caprine milk contained 3.70, 3.25, 4.30, 0.80, 12.05, 87.95 percent of fat, proteins, lactose, ash, total solids and moisture contents respectively.

The cow milk has3.90, 3.30, 4.50, 0.70, 12.40 and 87.60 percent of fat, proteins, lactose, ash, total solids and moisture contents respectively. The goat milk has recorded lower composition compared to cow milk sample. While it had

lower fat, protein and lactose and higher minerals as compared to cow milk. It is evident from the results (Table1) that there is no significant difference in value for the constituents like fat, protein, lactose, ash, total solids contents for cow and goat milk samples. The average gross compositions of caprine and cow milk are presented in the Table 1 and Figure 1.

Table 1: Gross Composition of Cow Milk and Caprine Milk

Constituents (%)	Cow Milk (n=20)	Caprine Milk (n=15)	CD≤0.05
Fat	3.90	3.70	0.16
Protein	3.30	3.25	0.17
Lactose	4.50	4.30	0.15
Ash	0.70	0.80	0.10
Water	87.60	87.95	0.46
Total Solids	**12.40**	**12.05**	**0.82**

All Values are Average of Six Trails

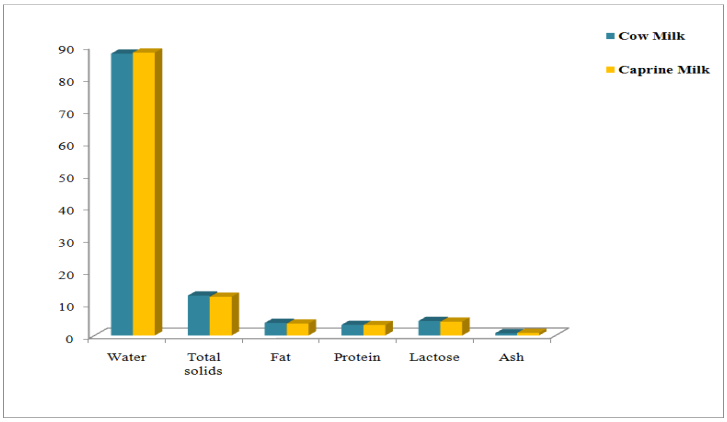

Figure 1: Gross Composition of Cow and Caprine Milk

Physico-Chemical Attributes of Cow and Caprine Milk

The physico-chemical attributes of cow and caprine milk is presented in the Table 2.

The physico-chemical characteristics of cow and caprine milk are mentioned in Table-2.

The average values of 1.032 and 1.030 were recorded in 27 ℃ for specific gravity of cow and caprine milk samples respectively. Caprine milk has exhibited lesser specific gravity as compared to cow milk. The average values for the viscosity of cow and caprine milk samples are 1.60 cp and 1.55 cp recorded at 25℃. The viscosity of caprine milk was found lower as compared to that of cow's milk. The average values for the surface tension of cow and caprine milk samples are 51.06 and 51.42 dynes/cm respectively at 25^0 C. The surface tension values of caprine milk samples were found to be higher as compared to cow's milk. The average freezing point of cow milk and caprine milk were -0.537 and –0.5070 C. Caprine milk exhibited lower freezing point compared to cow milk. However, the difference in freezing point of cow milk and that of the caprine milk was statistically significant. The average refractive index cow and caprine milk are 1.3424 and 1.3426 at 400 C were obtained for caprine and cow milk. Caprine milk has recorded higher refractive index than cow milk. The average values for electrical conductivity of cow and caprine milk are 0.0047 and 0.0053 mho's were recorded at 20℃. Caprine milk has recorded the highest electrical conductivity than cow milk.

Table 2: Physico-Chemical Attributes of Cow and Caprine Milk

Parameters	Cow Milk	Caprine Milk	CD ≤ 0.05
Specific gravity @27^{0}C	1.032	1.030	0.023
Viscosity (cp) @25^{0}C	1.60	1.55	0.029
Surface tension (dynes/cm) @25^{0}C	51.06	51.42	0.046
Freezing point (- ^{0}C)	0.537	0.507	0.018
Refractive index @ 40^{0}C	1.3425	1.3428	0.082
Electrical conductivity (mho) @20^{0}C	0.0047	0.0053	0.013

All the Values are Average of Three Trials

pH and Acidity of Caprine and Cow Milk

The pH and acidity of cow and caprine milk is presented in the Table 3. The pH and acidity of cow and caprine milk were 6.75, 0.135 per cent lactic acid, and 6.60, 0.164 percent lactic acid respectively (Table 2). Thus, goat milk had lowest pH and higher acidity than the cow milk.

Table 3: pH and Acidity of Cow and Caprine Milk

Milk	Parameters	
	pH	Acidity (% Lactic acid)
Cow	6.75	0.135
Caprine	6.60	0.164
CD ≤ 0.05	0.19	<0.001

Values are Average of Three Trials

Heat Coagulation Time (HCT) and Rennet Coagulation Time (RCT) of Cow and Caprine Milk

The HCT and RCT of cow and caprine milk are mentioned in Table 4. The average values obtained were 10 and 53 minutes for caprine and cow milk respectively at 140^0 C. The Heat Coagulation Time (HCT) of caprine milk was lower compared to cow milk and the average value of Rennet Coagulation Time (RCT) of caprine and cow milk was 45 and 35 minutes respectively at 30^0 C. The Rennet Coagulation Time (HCT) of caprine milk was higher compared to cow milk.

Table 4: HCT and RCT of Cow and Caprine Milk

Types of Milk	Parameters	
	HCT (Min)	RCT (Min)
Cow	53	26
Caprine	10	25
CD (P≤ 0.05)	<0.001	<0.005

Average of Three Trials

HCT - Measured at 140^0 C

RCT - Incubated at 30^0 C

DISCUSSIONS

The goat milk has recorded lower composition compared to cow milk sample. While it had lower fat, protein and lactose and higher minerals as compared to cow milk. The results are in agreement with [1] reported that cow milk contains higher fat, protein, lactose and lower minerals in cow milk than goat milk. [16] reported the reason for variation in the composition of different species milk.

Caprine milk exhibited significantly lesser ($p>0.05$) specific gravity, viscosity, freezing point & pH and higher ($p<0.05$) surface tension, refractive index, electrical conductivity & acidity were found statistically insignificant compared to cow milk. These results are in confirmation with [11].

The certain processing parameters of caprine milk of HCT and RCT were statistically lower ($p>0.05$) was observed compared to cow milk.

CONCLUSIONS

The caprine milk had lower fat, protein and lactose and higher mineral content than cow milk. The physico-chemical properties like specific gravity, viscosity, freezing point & pH exhibited lower and surface tension, refractive index, electrical conductivity and acidity were exhibited higher in caprine milk than cow milk. The HCT and RCT of caprine milk were lower compared to cow milk.

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